Project Title: "Monitored Natural Attenuation of Chlorinated Solvents"

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Collaborators: Minnesota Pollution Control Agency, U.S. Army, U.S. Air Force.

Introduction to the problem. Monitored natural attenuation is frequently used as a remedy or part of the remedy for ground water contamination from chlorinated solvents at Superfund sites. EPA guidance requires that the processes that cause natural attenuation be understood and documented on a site specific basis before monitored natural attenuation is accepted as a remedy.

Background: . Natural biological degradation through anaerobic reductive dechlorination is the most thoroughly studied process that accounts for natural attenuation of chlorinated solvents. Recently the capacity to carry out complete reductive dechlorination has been associated with a novel group of bactera (Dehalococcoides sp.), and a test for the presence of DNA from this group or bacteria is now commercially available. There is less understanding and appreciation of the role other anaerobic biodegradation processes in particular anaerobic biological oxidation by iron reducing bacteria. This is because biologically available iron III is insoluble and can not be sampled with a monitoring well. A commercial test or assay for the amount of biologically available iron in aquifer material has only recently become available. There is even less understanding and appreciation of the contribution of non biological transformations carried out by reactive minerals in the aquifer matrix.

Objectives: 1) Develop tools to determine whether reductive dechlorination is ongoing in the region of an aquifer that is sampled by a particular monitoring well (this information is needed to determine if attenuation seen in the past will continue into the future). 2) Develop tools to determine the capacity to biologically degrade chlorinated solvents that is associated with iron minerals in the aquifer. 3) Develop tools to predict the rate and extent of non-biological transformations of chlorinated solvents in contaminated ground water.

Approach: 1) Evaluate a commercially available genetic test for the presence of DNA from Dehalococcoides as a predictor of adequate rates of ongoing reductive dechlorination. This is being done by sampling for DNA from Dehalococcoides from plumes that currently exhibit or fail to exhibit significant rates of reductive dechlorination. 2) Evaluate and validate a commercially available bioassay for biologically available iron III. 3) Conduct microcosm studies contained "killed control" treatments using core materials from plumes that show apparent removal of dichlorethylenes without accumulation of vinyl chloride. Conduct analyses of minerals in the aquifer matrix (magnetite, mackinewite, pryrite, green rusts) that are known to transform chlorinated solvents or their daughter products.

Accomplishments to date (24 Feb 2003): The following articles have been published.

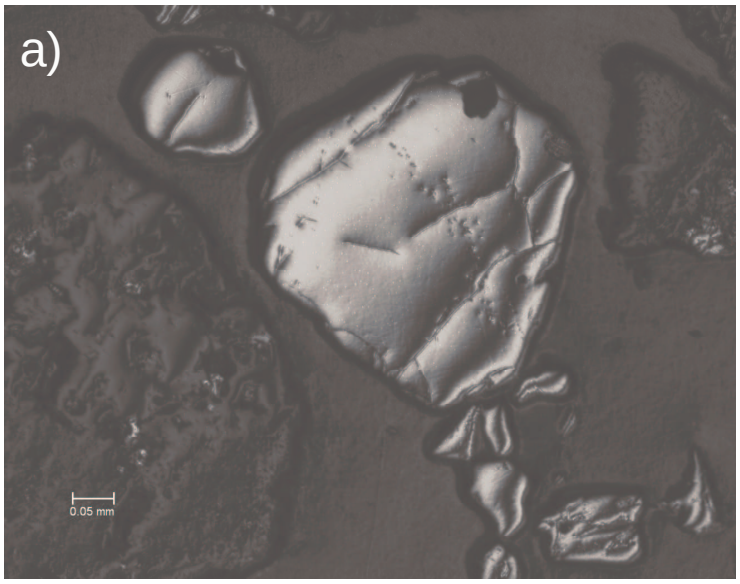
Evaluation of the Protocol for the Natural Attenuation of Chlorinated Solvents: Case Study at the Twin Cities Army Ammunition Plant. 2001. Wilson, J. T., D. H. Kampbell, M. Ferrey and P. Estuesta. (EPA/600/R-01/025) available internet only www.epa.gov/ada/pubs/reports.html

Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water. 1998. Todd H. Wiedemeier, Matthew A. Swanson, David E. Moutoux, E. Kinzie Gordon, John T. Wilson, Barbara H. Wilson, Donald H. Kampbell, Patrick E. Haas, Ross N. Miller, Jerry E. Hansen, and Francis H. Chapelle. (EPA/600/R-98/128) available at http://www.epa.gov/ada/reports.html

Near future tasks: A journal article is in review in review for Environmental Science & Technology titled "Non-biological Removal of cis-Dichloroethylene and 1,1-Dichloroethylene in Aquifer Sediment containing Magnetite". Mark L. Ferrey, Richard T. Wilkin, Robert G. Ford, and John T.Wilson.

A journal article is in preparation that compares the presence of Dehalocccoides DNA to the achieved rates of natural attenuation of chlorinated solvents in plumes of contaminated ground water.

A journal article is in preparation that evaluates the application of the commercially available test kit for predicting the concentration of biologically available iron III in sediment samples.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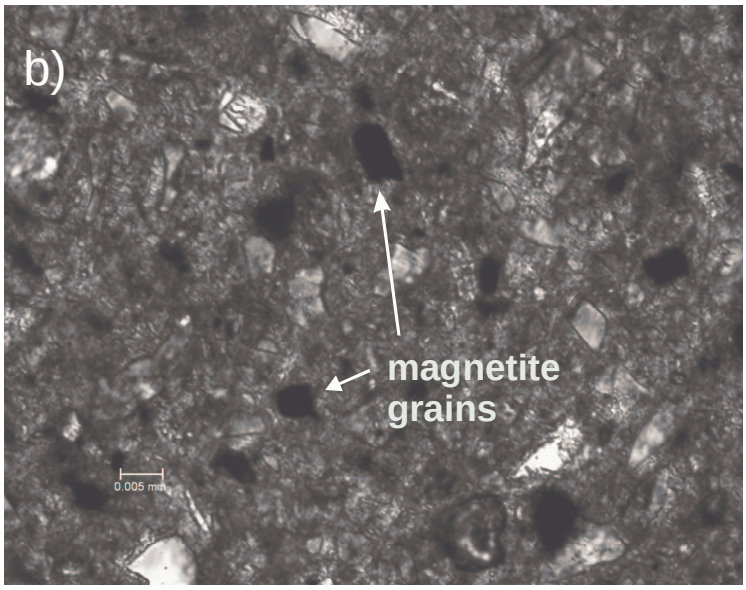
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